

# Vacuum Performance and Run-7

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## Outline

Major Vacuum Works during 2005 Shut Down  
and Run-6 Observations

Upgrades during This Shutdown

Perspectives for Run-7

## Major Vacuum Work in 2005 Shutdown

RF region: re-arranged the storage cavities

Polarimeters: lowered outgassing and added pumps

IR10: remove PHOBOS Be pipes, replaced with NEG coated pipes

Cold Bore improvement: pre-pumping, added ion pumps and IPC

Warm Bore NEG coated pipes: ~ 178m (total to 430m)

AGS IPC upgrade: installed 40 IPCs for 80 IPs in H10 house (1/3)

# RF Related Work in Sector #4

Relocation of SC: completed in 05 shutdown

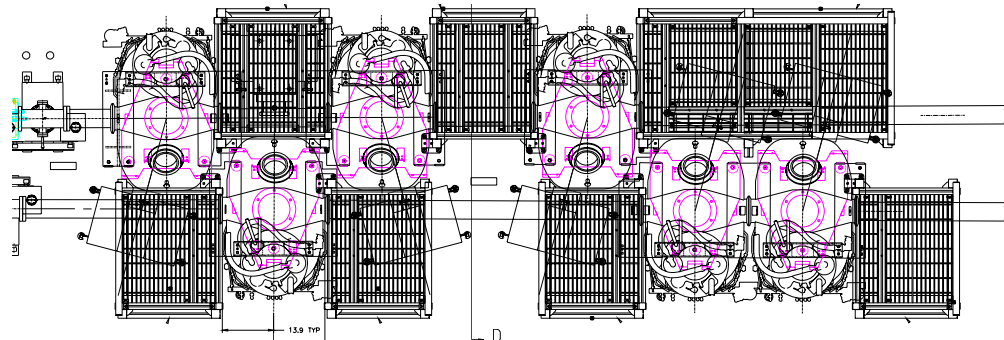
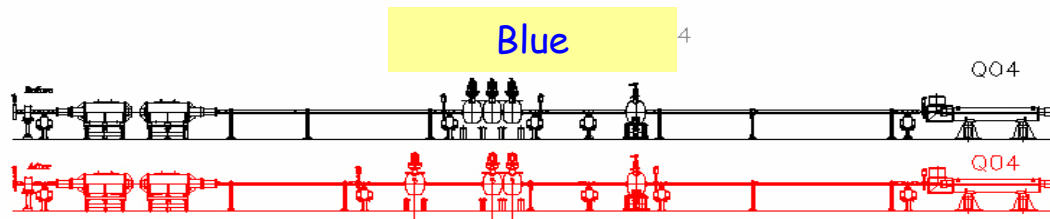
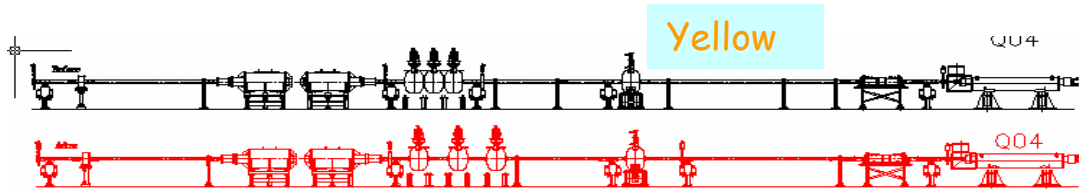
Two SC, IPs, GV, beam pipes, vacuum I&C

Platform, crane, plumbing, cabling, ....

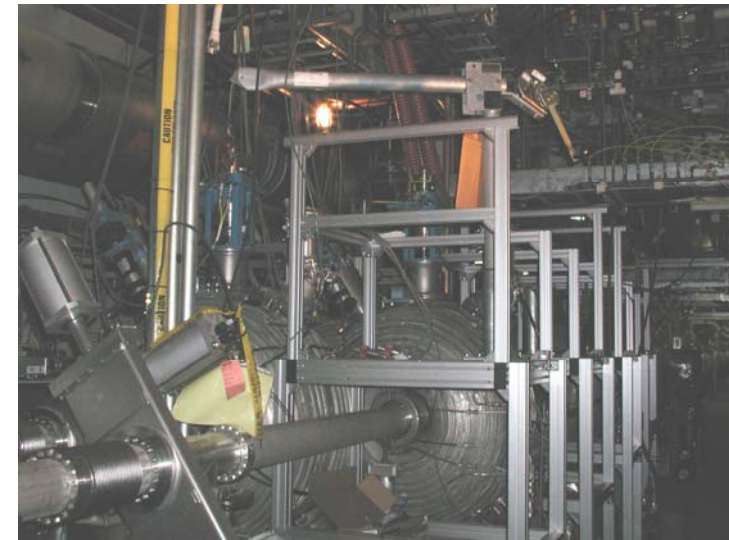
AC Tuner Repair/upgrade

SC Dampers Air Cooling Upgrade

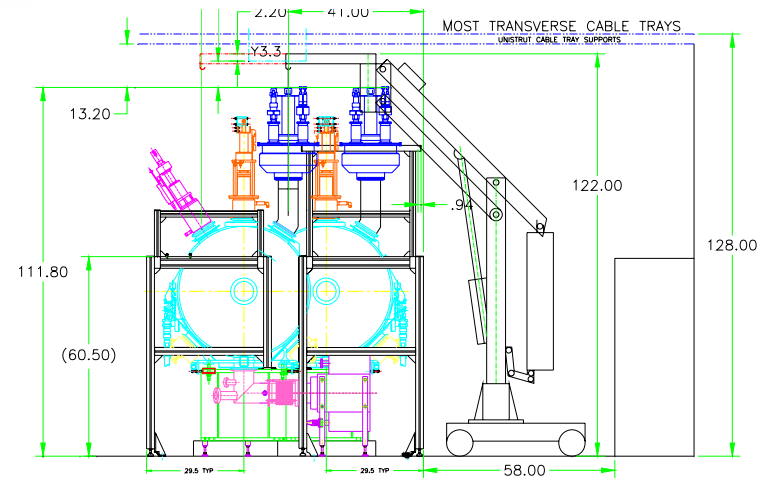
CC PA Window Upgrade/testing: on going this summer



Top view



Platforms w/ lifting cranes



# Polarimeter Vacuum Upgrade

During Run-5: long pump down time after target changes  
i.e.  $10^{-8}$  Torr after a week.

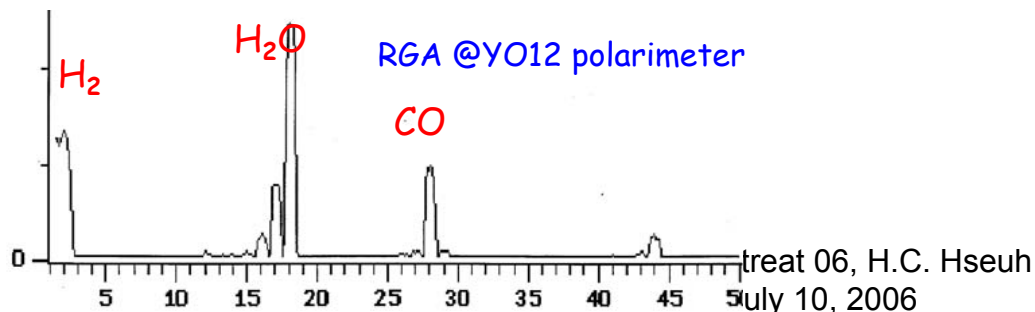
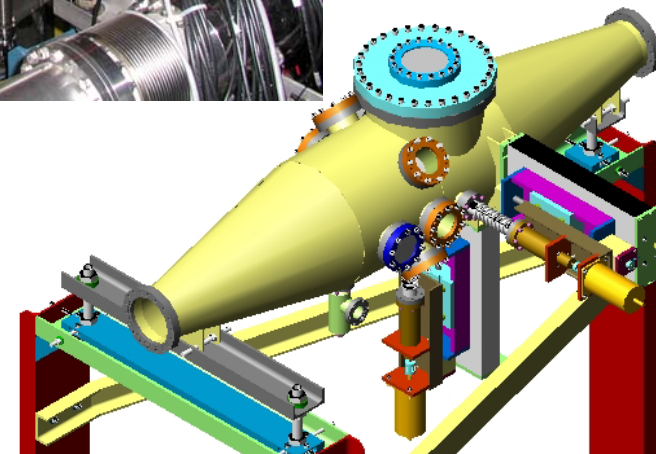
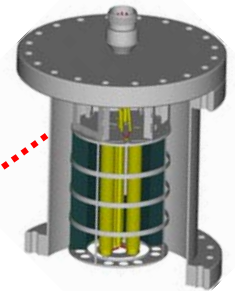
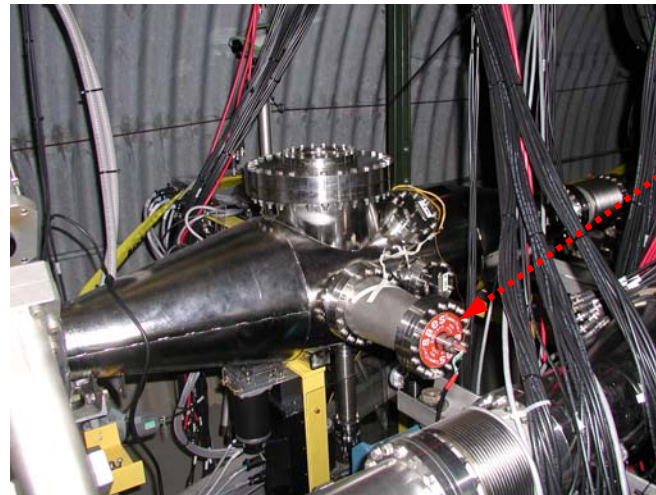
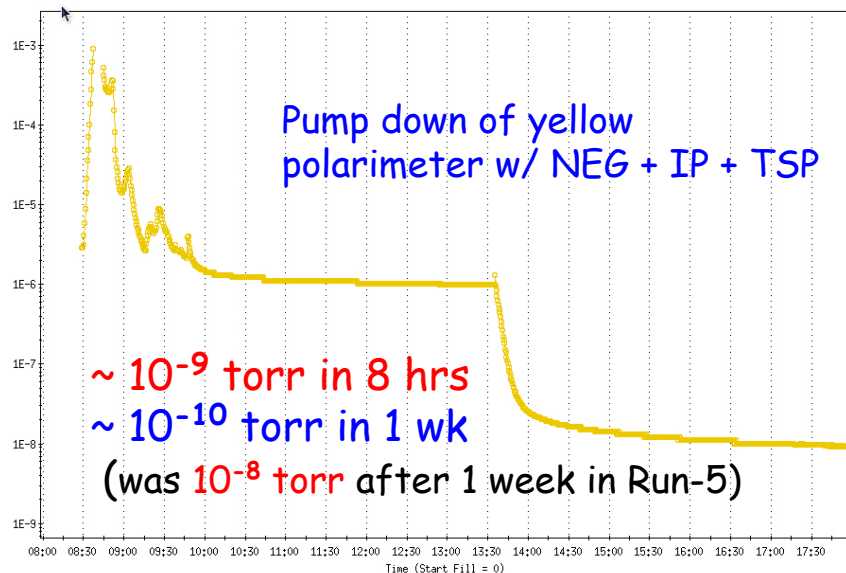
Achieved: **reduce outgassing**, faster pump down, higher UHV speeds

Identified high outgassing components: **Peek insulators (x 5)**

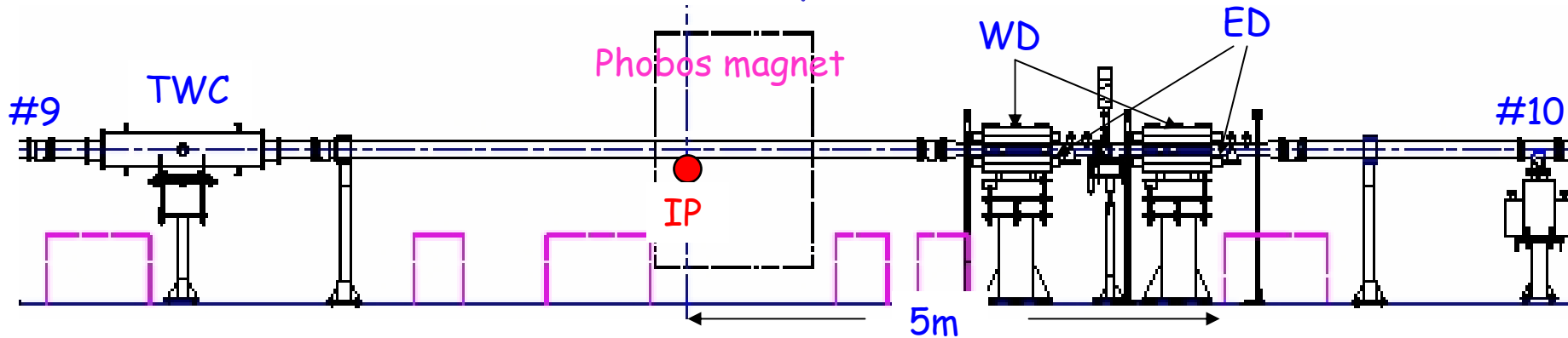
Added 500 l/s **NEG** cartridge pump and TSP sublimation (x 3)

Pump down time decreases by  $> 10$  (i.e. **low  $10^{-9}$  Torr** in 24 hrs)

NEG Cartridge



# New IR10 Layout



Removed 3x4m Be beam pipes (high  $\Delta P$  in Run-4 Au x Au due to high  $\eta_e$ )

Installed two CERN electron detectors (ED) and two warm dipoles (WD)

Installed 8.5m NEG coated beam pipes

⇒ P @ low  $10^{-11}$  Torr

Two warm dipoles (from yo5)

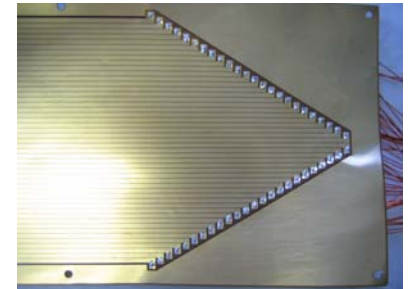
To enhance the electron signals

Gap: 24" L x 6" W x 5" H

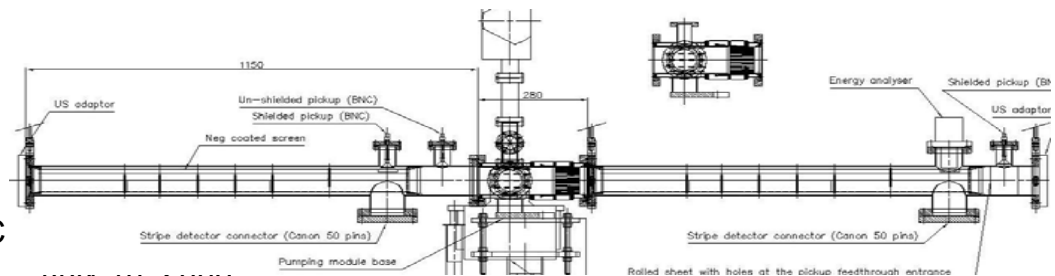
B: < 500 Gauss



RFD/Energy analyzer  
< 300 eV



Stripe detectors  
48x1mm



July 10, 2000



## Cold Bore in Run-4 & Run-5

40 C-B sections, 28 x 20m, 12 x 500m

C-B are usually at low  $e-10$  Torr

Observed C-B  $\Delta P$  to  $e-7$  Torr

with high intensity Au, Cu and  $p^{\wedge}$  ramps

Cu: 5919, 6103-06, 6250, 6530, ...

with  $5e+9 \times 40-49$  bunches

$P^{\wedge}$ : 3812, 5258, 5350, 7329-37, 7935...

with  $\geq 1.5e+13$  @ 110-bunch modes

Most  $\Delta P$  were at triplets and Q4 ends

a few  $\Delta P$  in the middle of arcs

## During Run-6

(after C-B upgrade)

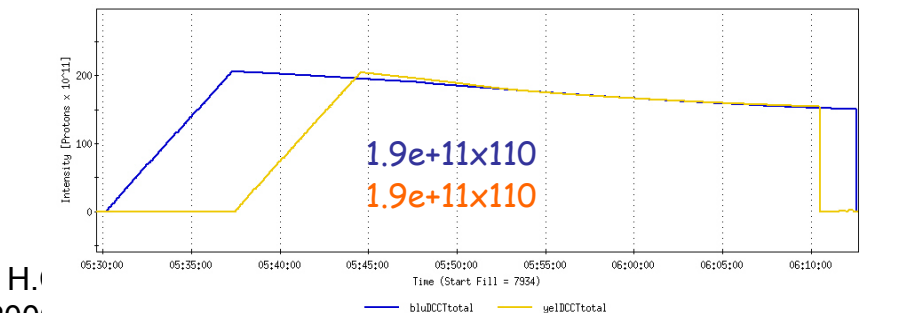
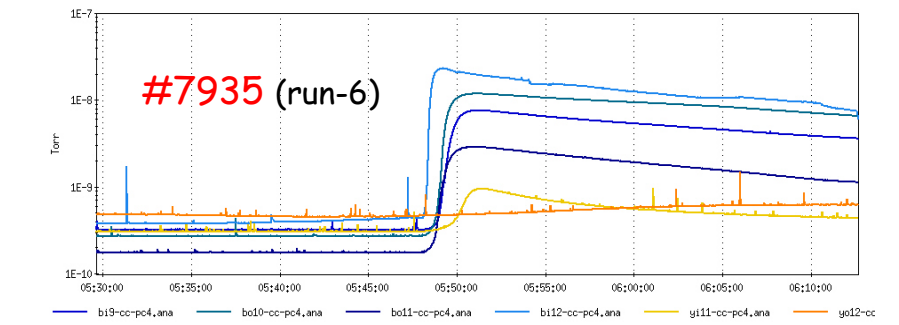
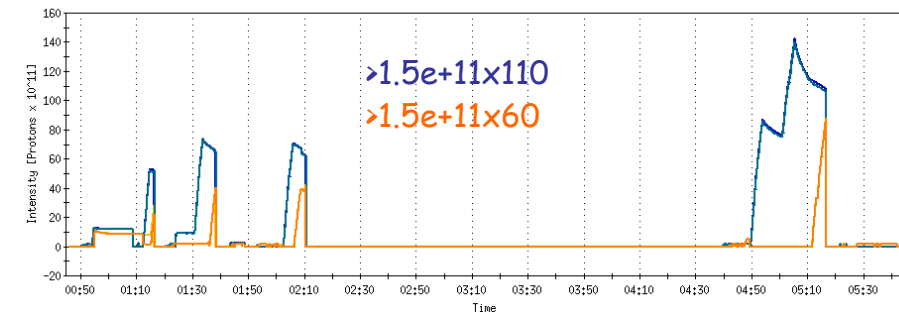
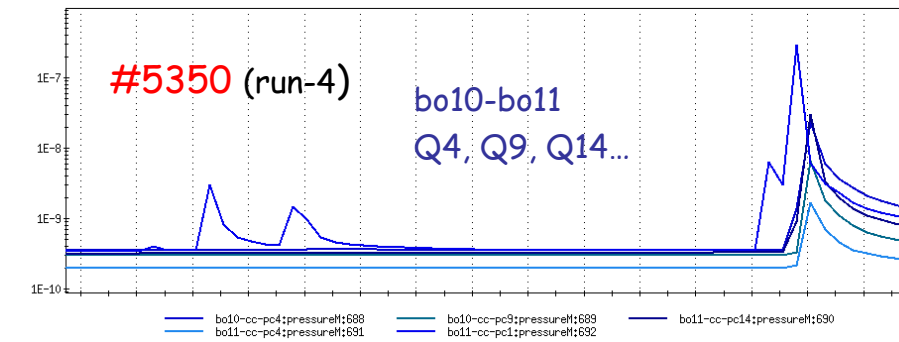
No significant  $\Delta P$

at triplets and in the middle of arcs

Some  $\Delta P$  at Q4 ends

$\sim$  one decade lower (to  $e-8$  Torr)

with higher intensity (#7935 vs. #5350)



# Cold Bore Upgrade (conti.)

## Pre-2005

C-B were pumped down in 1999 to  $\sim 10^{-4}$  Torr

No active pumping during annual warm up

$P$  to  $\sim 10^{-1}$  Torr =  $\geq 10$  monolayers

of adsorbed gas after cool down

No He background found after warm up

## 2005 Shutdown

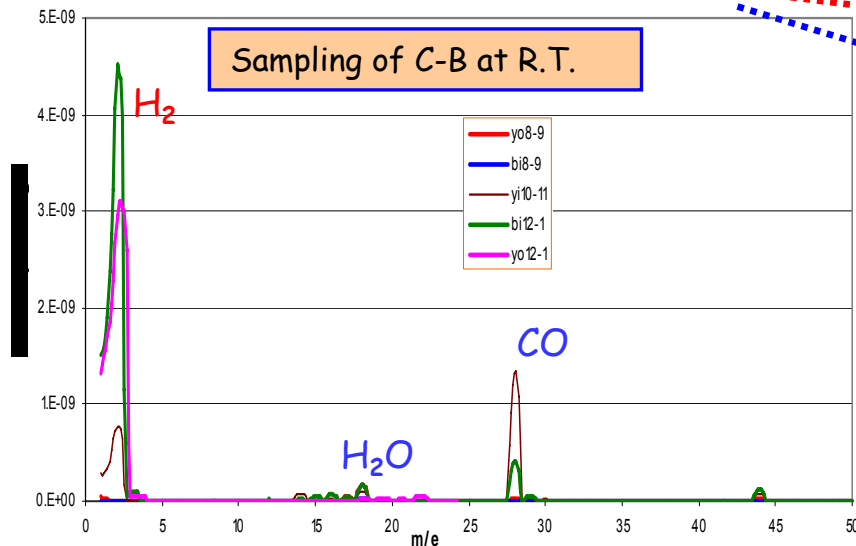
Sampled 5 arcs and 5 triplets with RGA

$H_2$  (90 - 14%)

Sections with highest  $\Delta P$

have highest  $H_2$  (BI12-1, YO12-1)

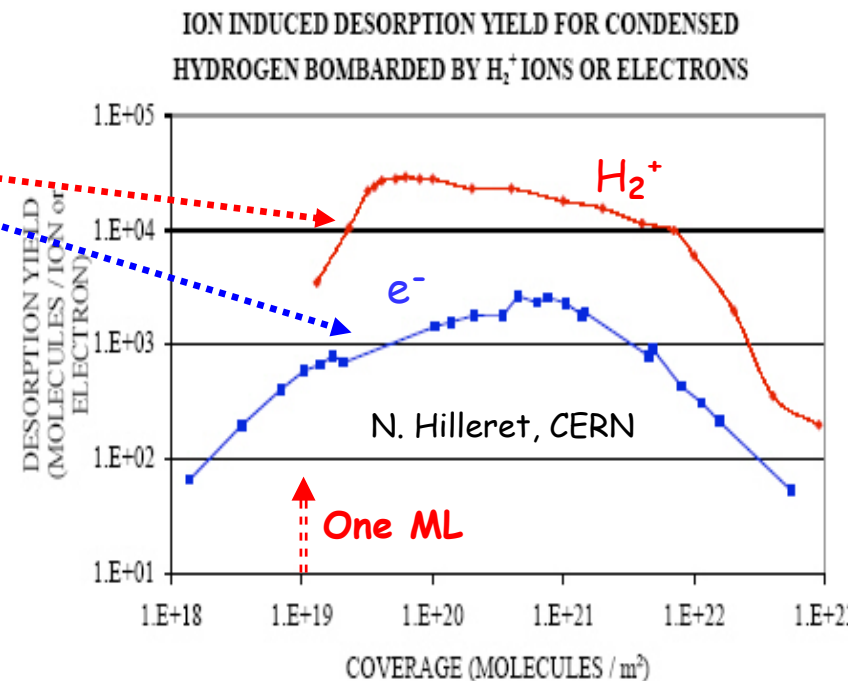
Condensed  $H_2$  has high desorption yields



## Goal of Upgrade:

$P < 10^{-6}$  Torr before cooldown

to reduce the physi-sorbed  $H_2$  to sub-sub-monolayers after cool down



# 2005 Cold Bore Upgrade

## Installed:

Six fixed TMPs to pump the 12 arcs  
Portable TMPs to pump the 28 triplets and inj.  
Four ion pumps per long arc (every 120m)  
One ion pump per triplet and inj. section

## Pumped down all C-B during O5 shutdown

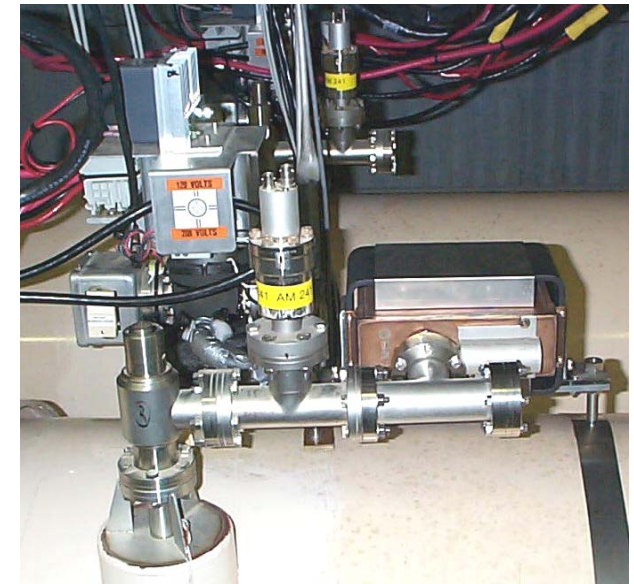
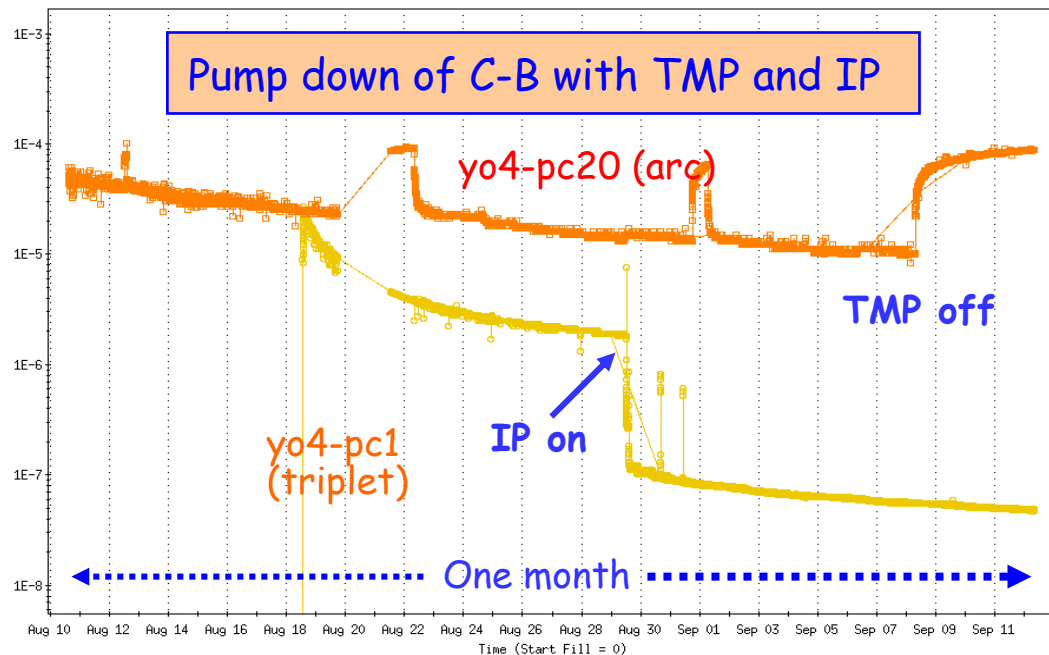
**Arcs:** ~2 months ( $\sim 10^{-5}$  Torr)  $\Rightarrow$  IPs to  $10^{-7}$  Torr

**Triplets:** ~2 weeks ( $\sim 10^{-6}$  Torr)  $\Rightarrow$  IP to  $10^{-8}$  Torr

2006 Warm Up to 80K: All C-B at  $10^{-9}$  Torr



C-B TMP for both arcs



Arc C-B IP mounted on cryostat



# NEG Coated Beam tubes in RHIC

## NEG (Non-Evaporable Getter) Coating of Ti-Zr-V alloy

sputter-coated on beam tubes,  $\sim 1 \mu\text{m}$  thick, by SAES Getters of Italy

< 600m beam tubes of 1.2 km W-B can be installed w/ NEG

activated at 250 C x 2-4 hrs at end of in-situ bake cycles

limited capacity & lifetime (< 10 activations) - not for high Q regions

57 m installed in 2003 shutdown - for evaluation

195 m installed in 2004 shutdown

178 m installed in 2005 shutdown

45 m to be installed this shutdown @ bi1, yo1, yo5

57m may be installed in 2007+ @ bo6, yi7, yo9 and bo10

IR10 and IR12 have NEG coated beam pipes of  $\sim 8\text{m}$  each

IR6 (Star) has  $\sim 5.6 \text{ m}$  of NEG coated pipes

IR8 (Phenix), IR4 (RF), IR2 (Brahms) have none

} Total: 463m

# Major Vacuum Upgrades in 2006 Shutdown

**IR12:** beam shutter upgrade ( $\tau = 10,000$  cycles)

**RF:** window coating and evaluation (Ti, Cu, porcelain)

**NEG coated pipes:** ~ 45m @ bi1, yo1 and yo5 (total to 463m)

**NEG coating of BBLR chambers:** to be installed at bi5 and yo5

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**AGS ion pump controller upgrade:**

**Complete E18 house** this shutdown

**H10 was completed last year**, A10 and Booster: 2007+

**AGS TMP Control and Gauging Development:**

Install and commission prototype TMP controllers @ A10 house

PLC based controls to replace the Datacon based system

Evaluate commercial gauge controllers for future upgrade

**EBIS:** Install cross-over pipes at LtB

**Booster:** Install new stripping foil chamber at BtA

# Run-7 Perspectives

Based on  $\Delta P$  during #7935  
 $1.9 \times 10^{+11} p^{\wedge} \times 110 \times 2$

## Warm Bore

### Low e-7 Torr:

IR4 (AC dipole and common cavities - not baked)  
IR8 (Phenix), IR10 (CERN ED)  
bo2-3.2 (IPM), yi7 (collimators), yo9-3.2 (dump)

### High e-8 Torr:

yo1-3.2 (IPM)  
bi4-3.1/3.2 (AC/SC), yo4-3.1/3.2/3.3 (AC/SC/SCK)  
bo10-3.2 (dump), IR12 (gas jet)

### Low e-8 Torr:

IR2, bi1, yi2, yo5, bo6  
bi8 (collimators), yo9-3.1, bo10-3.1 (dump kickers)  
bi12-3.3, yo12-3.3 (polarimeters)

Run-7 Perspectives  
Based on  $\Delta P$  during #7935  
 $1.9 \times 10^{+11} \text{ p}^{\wedge} \times 110 \times 2$

Cold Bore

A few  $\Delta P$  of low  $e-8$  Torr range

$$\Delta P(Q4) > \Delta P(Q1)$$

One decade lower than #5350 (with lower intensity)

Higher @  $y_{012}$ ,  $b_{i12}$ ,  $b_{o2}$  and  $y_{01}$

$\Delta P$  at other C-B were  $< e-9$  Torr

Need to reduce migration of warm  $H_2$  to cold bore

$$\text{i.e. } Q(H_2) \ll 1e-9 \text{ Torr} \times 500 \text{ l/s} \times 7 \text{ months}$$

$$= \sim 10 \text{ Torr} \cdot \text{liters} \approx 1 \text{ ML in arcs}$$

Do not expect C-B  $\Delta P$  to be an issue for Run-7

W-B  $\Delta P$  will dominate

# Summary

Installed > 80% NEG coated pipes at possible Q3-Q4 locations

NEG became saturated in weeks at regions with un-baked components

Need to evaluate individual beam components for

In-situ baking (at higher temperature?) to lower outgassing

Automated TSP sublimation (e.g. once a week) will help

Need to upgrade hardware and develop software

Additional pumping - NEG cartridge?

C-B  $\Delta P$  is not significant at present intensity

Additional ion pumps may be added in the arcs

H<sub>2</sub> migration from W-B (at Q4 ends) needs to be minimized

Polarimeters, IPMs, RF, ...

Develop upgrade plans in 2007 for luminosity goals in Run-8/9

IR8, IR6, IR4, IR2 and #4 Q3-Q4